DOCUMENT RESUME

ED 264 085 SE 046 212

AUTHOR	Raat, Jan H.; de Vries, Marc
TITLE	Technology as an Element of General Education: Characteristics and Themes of the Project Physics and Technology.
INSTITUTION	Eindhoven Univ. of Technology (Netherlands).
REPORT NO	N&T-85-12
PUB DATE	Aug 85
NOTE	13p.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*General Education; *Physics; Science Curriculum; Science Education; *Science Instruction; Secondary Education; *Secondary School Science; Student Attitudes; Technological Literacy; *Technology
IDENTIFIERS	*Netherlands; *Physics and Technology Project (Netherlands)

ABSTRACT

The need and impacts of technology are addressed in this report from the Netherlands. The position is stated that technology should be made a part of general education because of its growing influence on politics, social relations, and the economy. Topics addressed include: (1) the need for technology as an element of general education (outlining reasons in society and schools that necessitate technology's inclusion in the curriculum); (2) elements of technology that should be implemented in the curriculum (listing key assumptions); (3) strategies for incorporating technology into the general education curriculum (recommending that technology exists as a separate subject and/or as a part of the physics curriculum; (4) characteristics of the project Physics and Technology (discussing the procedures and processes involved in the project); and (5) themes of the project Physics and Technology (presenting the four current themes and also titles of five potential topic areas). Appendices contain a summary of conceptions and attitudes about technology from 13-year-old students and tables of contents for the identified themes of the Physics and Technology project. (ML)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED264085

TECHNOLOGY AS AN ELEMENT OF GENERAL EDUCATION

Characteristics and themes of the project Physics & Technology

Jan H.Raat
Marc de Vries

Eindhoven University of Technology
Eindhoven, The Netherlands

SE 046212

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Dr. Jan H. Raat
Eindhoven Univ. of Technology
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Address of the authors:

prof.dr. Jan H.Raat

drs. Marc de Vries

Eindhoven University of Technology

Postbox 513

5600 MB Eindhoven

The Netherlands phone (0)40 474331

& 473095

TECHNOLOGY AS AN ELEMENT OF GENERAL EDUCATION

Characteristics and themes of the project Physics & Technology

SUMMARY

Two reasons make there is a need for technology as an element of general (secondary) education.
Firstly, technology influences economy, politics and social relations thoroughly. Industry is changing rapidly by the big technological developments of the last 25 years.
These facts still have had hardly any influence on general education.
Secondly, more than 50% of the professions now are technical in nature. In many countries pupils have to make first choices concerning their further schooling process and the future profession at a rather early age, pupils being between 13 and 15 years of age. What do they know about technology?
We think it is necessary to make technology part of general education.

Then the question arises: what elements of technology should be present in the curriculum. Several aspects of technology are essential: technology is determined by human beings; it concerns itself with changes in form and position of matter, energy and information; it consists of products and of processes; it is strongly related with physics; in technology working with your hands plays an important role; technology has a great impact on society.

Technology can be made part of the curriculum in general (secondary) education by creating a new, separate subject 'technology'. We think all schools in general secondary education should have technology as a separate subject.
Another strategy is to bring in parts and elements of technology in the physics curriculum. This is done in the *project Physics & Technology* (P&T).

In the project P&T themes for physics have been written and are written in which technology plays an important role.
Four themes are available in a first version: Electrical equipment at home, Communication, Water at home, Making musical instruments. The text has been written in Dutch. An English version of the theme 'Pieces of electrical apparatus at home' is available.
The contents of the 4 themes are given as well as some characteristics of the project P&T.

An evaluation of the these themes and others, having been used in schools, can show what elements of technology can succesfully be implemented in the physics curriculum.
These elements can also become parts of the curriculum of a new subject 'technology'.

Adress of the authors:
prof.dr. Jan H.Raat
drs. Marc de Vries
Eindhoven University of Technology
Postbox 513
5600 MB Eindhoven
The Netherlands

phone
(0)40 473095
& 474331

The need for technology as an element of general education

In the few past decades the impact of technology has increased greatly. Technology influences economy, politics and social relations thoroughly. Industry is changing rapidly as a result of the big technological developments of the last 25 years. Think of automation, information technology and robots. Vice versa the use of modern techniques can stimulate industrial development.

These facts still have had hardly any influence on (general) education. Many students and pupils leave school without having been confronted with technology. Incidentally parts of technology are mentioned in e.g. physics lessons, but no structured attention is paid to technology.

The reason for this is easily given. Education often, if not always, is in arrears.

It is our task to introduce technology into the curriculum.

There is another reason to do this. More than 50% of the occupations now are technical in nature. In most countries pupils have to make important choices at a rather early stage in their education. We here think of choices concerning the further schooling process and particularly the future profession. Frequently first choices have to be made in the lower part of secondary education, pupils being between 13 and 15 years of age.Is then their perception of technology clear enough to make a good and relatively well balanced decision at that point? What do they know about technology?

Investigation has shown that 13-year-old pupils have an incomplete and distorted conception of technology. See our paper 'What do 13-year-old pupils think about technology'. Appendix 1 of this paper contains its summary.

We think it is not only desirable but also necessary to make technology part of general education.

What elements of technology in the curriculum?

What elements of technology should be implemented in the curriculum?

To answer this question it is necessary to make clear to ourselves what technology is.

In our opinion these aspects of technology are essential to technology:

-technology is determined by human beings. The human being, and not the machine, is central in technology;

-technology concerns itself with changes in form and position of matter, energy and information;

-technology does not only consist of products (machines, appliances) but also of processes (problem solving, designing, doing experiments);

-technology and physics (science) are related very strongly;
-in technology working with your hands often plays an important role;
-technology has a great impact on all aspects of our society.

The research into the concept that 13-year-old pupils have of technology, already mentioned before, demonstrates that these pupils have a vague conception of technology. They do not see the importance of desiging in technology; the relation between physics and technology is very unclear to them; they are not very acquainted with technology. This goes for girls even more than for boys.

How to make technology part of the curriculum in general education?

There are several possible strategies to make technology part of the curriculum in general education, especially in secondary education.

One strategy is to have technology as a separate subject. Some schools spend about 2 lessons a week at 'handicraft': sawing, soldering -mostly for boys- and sewing, cooking -mostly for girls-. These lessons can have a tradition of several decades. Some times they prepare(d) pupils for simple jobs. These lessons can have a low prestige at school.

We think all schools in general (secondary) education should have technology as a separate subject. Those schools that have the more old-fashioned handicraft as a subject should change this to technology.

Technology as a separate subject should offer the same curriculum to girls and boys. We refer to our MENT-project. In this project we do research in the field of: the position of girls and women in physics- and technology-education.

Another strategy is to bring in some parts and elements of technology in the physics curriculum. As noted before, physics and technology are strongly related. For many centuries there has been a mutual influence between physics and technology; this mutual influence still is very big. Before 1800 technological problems gave impulses to physicist to do fundamental research. Nowadays technology is developed largely with the results of physical research as a basis. This justifies the strategy we chose in our project *Physics & Technology* to make technology part of the physics curriculum.

Some characteristics of the project Physics & Technology

In the project Physics & Technology (P&T) we like to introduce some elements of technology into the curriculum of general secondary education.

In The Netherlands there still is no separate subject 'technology' in the curriculum. So we look for a subject in which elements of technology can be incorporated. The subject that is most apt for this is physics.

Our strategy is to develop some themes for physics in which technology plays an important role. We do not construct a complete curriculum. In the project P&T only parts of a curriculum are constructed, to be seen as examples of what is possible.
This work in P&T is done in close cooperation with 9 physics teachers in secondary general education. A cooperation between curriculum experts and teachers has advantages: curriculum experts can bring in their knowledge of the curriculum development process and teachers can contribute with their experiences in the every day teaching practice. A curriculum that is developed in this way can be implemented better than a curriculum that is constructed by a teacher training and research institute only.
After the themes have been written and used in the classroom an evaluation takes place. It takes about 10 classes to get information for this (formative) evaluation.
With the results of this evaluation as a basis the themes are rewritten. The revised versions are used in a larger number of classes (some 40).
Then a second, summative, evaluation takes place.
The aim of this evaluation is to find out what elements of technology can be succesfully implemented in the physics curriculum.
These elements can also become parts of the curriculum of a new subject 'technology'.

The themes of the project P&T

So far 4 themes are available in a first version.
Titles are: Electrical equipment at home; Communication; Water at home; Making musical instruments.
The text has been written in Dutch. English translations are being made. An English version of the theme 'Electrical equipment at home' is already available now.
Some further themes that will be written are: Do-it-yourself; Lighting; Medical Technology; Transport; Energy & Industry.
Appendix 2 shows the tables of contents of the themes that are available.

Each theme begins with a paragraph about the physical concepts and laws that are necessary to understand the rest of the theme.
In the second paragraph the elements of a technical design are shown. The pupils design a simple apparatus themselves.
The next two paragraphs make pupils more acquainted with two appliances they often meet in their daily life.
The last paragraph helps them to reflect on the meaning of technology in their own life.

In each theme special attention is paid to appeal to girls. In the text and in the illustrations there are girls as well as boys.
Another common item in the themes is information about technical professions.

By constructing the themes in this way we expect that
-pupils understand the relation between physics and technology;
-pupils see the role of designing things in technology;
-pupils are helped in making a decision about their future occupation;
-girls get more interested in and more acquainted with technology.

Material for internal differentiation is provided: in each theme there are revision sheets and additional material.

For each theme a teacher guide is developed.

APPENDIX 1 *What do 13-year old pupils think about technology?*
The conception of and the attitude towards technology of 13-year old girls and boys

SUMMARY*

In The Netherlands as in many countries students have to make their first choices concerning study and future profession at an age of 13 to 15 years.
As for technology, the curriculum does not prepare pupils well in making these important choices. One can wonder if pupils at that age have knowledge enough to make decisions that can have so big consequences. What do 13-year-old pupils know about technology? What is their interest in it? From experience in the MENT-project as for the relation 'girls and physics' we expect 13-year-old girls to have less an idea of what technology is than boys have and a less positive attitude towards technology.
To test these hypotheses we do an investigation in the conception of and attitude towards technology of 13-year-old students.

As a first step we interviewed 12 students, asking them questions such as: what do you think technology is, how important is technology to you?
Secondly, we asked 48 pupils of two different schools to write down their ideas about technology, answering 10 open-ended questions we offered them.
The answers we got in both steps were used to construct a questionnaire consisting of 80 questions to be answered in a 5 point Likert-scale. The questions could be divided in 8 sections: general knowledge of technology, interest, importance etcetera.
To avoid misunderstanding: the questions in the questionnaire were not grouped in these sections; they were offered in a mixed order.
The questionnaire was offered to some 3.000 13-year-old pupils of different types of schools in different parts of the country.

The results were factor-analysed. 20 factors were found of which 14 could be identified. Factor scores were computed and the differences between girls and boys were tested for significance.

Conclusions are that it is difficult for pupils to indicate what technolgy is. They are aware of the importance and the diversity of technology.
Girls are less interested in technology than boys are.
Girls as well as boys think that girls are apt for technology.

To have first possibilities to compare the results with other countries a translation of the same questionnaire is offered at Polish pupils of the same age. There is correspondence and arrangements are made with investigators in Australia, Canada, Hungary, Nigeria, USA and UK to do the same.
First results of a pilot study will be discussed in an workshop at the Eindhoven University of Technology, The Netherlands, March 1986.

*This is a summary of the paper
What do 13-year old pupils think about technology?

APPENDIX 2. *Tables of contents of written themes.*

Electrical equipment at home

1. Concepts in physics, electricity
2. Designing a piece of electric equipment
3. The coffee machine
4. The iron
5. Usage of electric equipment at home

Revision sheets

1. Concepts in physics
2. Designing a piece of electric equipment
3. Coffee machine and iron

Additional material

1. History of electric equipment
2. Appliances with electro-magnets
3. Repairing electric equipment

Communication

1. Concepts in physics: electricity and light
2. How to convey a message over a great distance
3. The telephone
4. The optical fibre
5. Communication in our world

Additional material

1. Concepts in physics
2. Designing tele-communication equipment
3. Telephone and optical fibre

Revision sheets

1. History of tele-communication: from semaphore to satellite
2. Making a model of an optical fibre
3. Experiments with phones

Water at home

1. Concepts in physics: fluid pressure and heat transport
2. How water is supplied at home
3. The gas-heater and the boiler
4. Taps and the WC
5. Using water economically

Revision sheets

1. Concepts in physics
2. How water is made available at home
3. Gas-heater, boiler, taps and the WC

Additional material

1. History of water-supply
2. Making clean drinking water
3. Central heating

Making musical instruments

1. Concepts in physics: sound
2. Designing and making a flute
3. The guitar
4. Electrical instruments
5. Music in your life

Revision sheets

1. Concepts in physics
2. Designing and making musical instruments
3. Guitar and electrical instruments

Additional material

1. History of electrical instruments
2. Building an electrical guitar
3. The trumpet

vakgroen didactiek natuurkunde
afdeling der technische natuurkunde
TH Eindhoven

N&T 85-12